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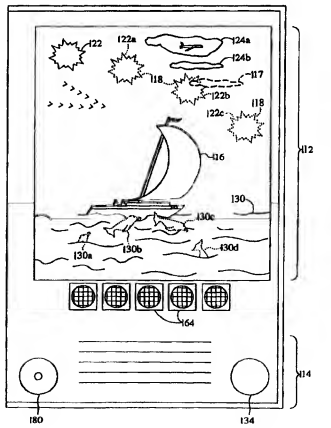
(57) Abstract

A panel, page or substrate (112) is provided having a tier of electroluminescent (EL) material which forms a pattern corresponding to a series of images (130a-d). When illuminated in accord with a predetermined sequence, the series of images provide an illusion of movement. A sound generator (134) is provided to produce a predetermined audible response associated with the predetermined sequence. One or more flexible membrane switches (164) are coupled to simultaneously activate both the EL material and the sound generator when depressed. The panel may be embodied as a flexible web that is adapted to roll up over a spring loaded shaft.



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ELECTROLUMINESCENT DISPLAY APPARATUS

TECHNICAL FIELD

The present invention pertains generally to the field of electronic displays. Specifically, the present invention pertains to electroluminescent display apparatus ideally suited for educational and entertainment presentations and advertising displays.

BACKGROUND ART

Electroluminescent (EL) devices, used in pages, panels, displays and board games, generally comprise a layer of phosphor disposed between two electrodes, at least one of which is light-transmissive. A dielectric is also disposed between the electrodes, so the EL device functions essentially as a capacitor. When a voltage of alternating current is applied across the electrodes, the phosphor material is activated and emits light.

EL devices may be manufactured as discrete cells or as large panels or rolls and either on rigid or flexible substrates. In addition, each component of the device may be formed as a separate layer, such as a foil sheet serving as an electrode, and a planar dielectric sheet, with the layers later laminated together as by heat and pressure. Alternatively, the layers may be combined into overlapping coatings printed on a substrate, as is the case for a layer of light-transmissive conductive ink serving as a top electrode followed by a layer of phosphor ink in a dielectric matrix and then another conductive ink coating serving as a back electrode. EL devices have found widespread uses, e.g. in signs, watch faces, and as backlighting for keyboards.

Membrane switches are generally constructed of two spaced-apart electrically conductive surfaces on separate substrates. At least one substrate is flexible. For example, each conductive surface may be a pattern of electrically conductive ink. A spacer layer with an aperture is positioned between the two facing conductive surfaces. When a user depresses the flexible substrate containing one of the conductive surfaces, the two conductive surfaces come into contact thereby causing activation of the switch and closing a circuit. Membrane switches have also been used in a variety of devices, such as on keyboards and control panels for appliances. See, e.g., U.S. Pat. No. 4,683,360 to Maser for a membrane switch combined with an EL lamp panel.

U.S. Pat. No. 4,683,360 to Maser discloses a combined electroluminescent panel activated by a flexible membrane switch. The flexible membrane switch is generally constructed of two spaced-apart electrically conductive surfaces on separate substrates. At least one substrate is flexible. For example, each conductive surface may be a pattern of electrically conductive ink. A spacer layer with an aperture is positioned between the two facing conductive surfaces. When a user depresses the flexible substrate containing one of the conductive surfaces, the two conductive surfaces come into contact, thereby causing activation of the switch and closing a circuit.

U.S. Pat. No. 4,532,395 to Zukowski discloses a combination flexible membrane switch panel disposed adjacent to flexible EL material. The flexible membrane switch includes two spaced-apart electrically conductive surfaces on separate substrates with a spacer layer, having an aperture positioned therebetween. One of the conductive surface is flexible, with another flexible layer, having translucent indicia, positioned adjacent to and spaced apart therefrom. Disposed between the translucent indicia and the flexible membrane is a flexible layer of

EL material. In this manner, both the indicia layer and the EL material may be depressed to allow operation of the flexible membrane switch.

Many interactive games and learning devices include flexible membrane switches to allow a user to control some elements of the stimuli these devices produce. In this fashion, the games and learning devices are more likely to hold the attention of a user for a longer period of time when compared to passive devices.

U.S. Pat. No. 5,087,043 to Billings et al. discloses an interactive audio-visual puzzle that includes, in pertinent part, a rigid puzzle form defining a predetermined number of form cutouts, an upper graphic disposed on the form upper surface and a plurality of respective removable puzzle pieces. Each of the puzzle pieces includes a peripheral configuration conforming to that of an associated form cutout and bears a piece graphic. A flexible membrane bears on the underside thereof, along with a plurality of conductors in a predetermined relative disposition. A plurality of respective lower graphics overlie the flexible membrane and underlie the form cutouts. A sound generator produces respective predetermined associated sounds in response to the input signals applied thereto. The flexible membrane conductors, space and ground plane cooperate to form a touch-pad which corresponds to each of the lower graphics electrically connected to the sound generator. In this manner, the sound generator is selectively actuated to produce sounds in response to input signals. A drawback with Billings et al. is that no animation is provided which would provide the puzzle with more appeal to a user.

U.S. Pat. No. 4,703,573 to Montgomery et al. discloses a visual audible activated work that includes, in pertinent part, at least two pages pivotally attached to each other so that the pages are pivotal from a juxtaposed closed position to an adjacent opened position. A liquid crystal display (LCD) is affixed to one of the pages. A sound generator is attached to the LCD, and a power supply is coupled to automatically provide power to both the sound generator and the LCD when the pages are paced in the opened position. A drawback with Montgomery et al. is that the LCD display limits the number and variety of interactive devices that may be present on any given page.

A variety of billboard and signboard systems are available for indoor and outdoor advertising. U.S. Pat. No. 5,123,192 to Hsieh discloses a display system that includes a liquid crystal display plate. The display plate is typically positioned indoors between a product to be advertised and a store-front window. The display pate is visible from the outside, and is adapted to alternatingly become transparent and translucent. In this fashion, the display plate periodically forms images which may associated with the product and allows viewing of the product through the windows, without any images being present.

U.S. Pat. No. 4,739,567 to Cardin discloses a display system for a store-front window that includes a retractable projection screen, a slide projector and a mirror. The projection screen is disposed proximate to the window, with the mirror disposed opposite to the window. The slide projector is positioned to direct an image away from the window onto the mirror. The mirror is orientated to project the optical image information onto the screen. A timer is employed to allow the screen to be periodically retracted. Typically, the timer means retracts the screen during the daylight hours so that the store-front window may be used as a simple display window. During the evening hours, the projector screen is lowered so that images may be viewed thereon. A second timer means is employed to sequence the slide projector through the que of slides contained therein. A

drawback with the two aforementioned systems is that they are relatively complicated, requiring precise orientation of the various components of the system, thereby precluding portability.

Many portable viewing screens are available in the prior art. U.S. Pat. No. 4,169,658 to Brown and U.S. Pat. No. 4,110,003 to Zinn each discloses a portable projection screen that includes a flexible viewing surface. The flexible viewing surface is typically stored in a portable housing and may be extended therefrom to facilitate viewing optical information generated from, for example, movie or slide projectors. A drawback with these devices is that the operation of the screens depends upon the availability of a projection system. In addition, as discussed above in regard to U.S. Pat. No. 4,169,658, there is difficulty in comprehending the optical information viewed, outdoors, on a projection screen during daylight hours.

Other displays have been manufactured from electroluminescent (EL) devices, which generally comprises of a layer of phosphor disposed between two electrodes, at least one of which is light-transmissive. U.S. Pat. No. to Veltri et al. discloses such a display which includes an EL strip adapted to function as a belt to form to the body of a wearer. The low power requirements of the belt allow the EL material to be powered by a battery. The EL material allows the wearer to be seen at night and during low-light conditions, for example, during dusk. While highly portable, the belt does not afford a sufficient amount of surface area to function effectively as a display for advertisements.

An object of the present invention is to provide an apparatus utilizing electroluminescent display means and membrane switches for imparting educational and entertainment information in an interactive manner.

Another object of the present invention is to provide an interactive page or panel device with audio visual stimuli in which the visual aspect of the stimuli provides an illusion of movement.

Another object of the present invention is to provide an increased number of interactive devices per unit area than interactive devices of the prior art.

A further object of the present invention is to provide an audio visual system which is easily adaptable to existing interactive devices.

A still further object of the present invention is to provide a portable display device that has sufficient surface area to capture the attention of listeners and viewers and have them perceive a message contained thereon in various lighting conditions.

SUMMARY OF THE INVENTION

In one embodiment the above objects have been achieved with an interactive book comprised of a series of individual display pages. Each page includes a character-bearing, printable layer overlying a spatially-arranged display pattern of electroluminescent (EL) lamps with at least one EL lamp positioned directly underneath each character that has been selected for illumination. Each page also includes a membrane switch having an imprinted activation region which, when depressed by the user, closes the circuit for at least one EL lamp on the page and thereby causes activation of the lamp and illumination of the overlying character. By printing with various inks and on various surfaces, the EL lamps can be used to make characters appear and disappear, as well as change color.

A sequencing circuit is operably connected to the electrical circuitry of at least some of the EL lamps on a page. The sequencing circuit is triggered by the touch of a membrane switch, as with the circuitry for the simple illumination of lamps. The sequencer is set for a specific pulse rate and order, causing timed and ordered activation of the EL lamp series. Precise timing and ordering of the sequenced series in combination with careful placement of printed characters on the display page provides motion effects, such as animation, of the characters.

In a second embodiment a substrate including a tier of electroluminescent (EL) material forms a pattern which corresponds to a series of images that provide an illusion of movement when illuminated in accord with a predetermined sequence. A sound generator is used to produce predetermined audible tones or words linked in meaning to the images. A flexible membrane switch is coupled to simultaneously activate both the EL material and the sound generator when depressed by a user. A layer includes a plurality of icons, with each of the plurality of icons being associated with one of a first and second set of illustrations. The first set of illustrations is adapted to be viewable with an unaided eye on a continuous basis, and the second set of illustrations comprises the pattern of the EL material and are selectively viewable with the unaided eye, when the EL material illuminates. The sound produced by the generator may or may not be a succession of audible responses corresponding to the predetermined sequence. Each audible response of the succession may or may not be uniquely associated with one of the illustrations of the second set.

In another alternative embodiment a roll-up display for use in making presentations includes a flexible web with a light emitting pattern disposed thereon which comprises of a tier of electroluminescent (EL) material, covered by a top layer. One end of the flexible web is mounted to an elongated member. The flexible web is adapted to move between extended and closed positions. In the closed position, the flexible web is coiled around an axis of the elongated member. In the extended position, the remaining end of the flexible web is positioned distally from the elongated member. Circuitry is attached to the elongated member to activate the EL material to produce light. A sound generator is coupled to a speaker, both of which are attached to the circuitry to produce predetermined audible signals. A sensor is coupled to the circuitry, causing it to activate the EL material, and/or the sound generator, in response to the sensor detecting one or more stimuli, e.g., motion, heat or sound. The display panel may also include a hollow body with the elongated member disposed within the body to rotate about the axis of elongated member. The body is adapted to encase the flexible web upon reaching the second position.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a typical page layout for a character-bearing printable layer, according to a first embodiment of the present invention, and also shows an example of the spine of a book having the display pages of the present invention.

Fig. 2 is an exploded view of some of the layers of a typical display page of the present invention, with most of the electrical circuitry removed.

Fig. 3 provides an exploded view of a membrane switch according to the present invention.

Fig. 4 is a cross-section of a typical double-sided display sheet of the present invention.

Fig. 5 is a cross-section of an alternate embodiment of a double-sided display sheet according to the present invention.

Fig. 6 is a cross-section of another alternate embodiment of a double-sided display sheet according to the present invention.

Fig. 7 is a block diagram of the typical electrical circuitry of the present invention.

Fig. 8 shows a typical layout for an icon bearing layer which is associated with a substrate in accord with an alternative embodiment of the present invention.

Fig. 9 is an exploded view of some of the layers of a typical substrate of Fig. 8, with most of the electrical circuitry removed.

Fig. 10 is another exploded view of a flexible membrane switch in accord with the present invention.

Fig. 11 is an exploded perspective view of electric circuitry and a housing associated with the embodiment of Fig. 8.

Fig. 11A is a perspective view of another alternative embodiment of the present invention in an extended position.

Fig. 11B is a detailed view of the invention shown in Fig 11A.

Fig. 12 is an exploded perspective view of the invention shown in Fig. 11A.

Fig. 13 is a perspective view of the invention shown in Fig. 11A in a closed position.

Fig. 14 is a perspective view of yet another alternate embodiment of the present invention.

Fig. 15 is an exploded view of layers of a typical substrate of the present invention, with most of the electrical circuitry removed.

BEST MODE FOR CARRYING OUT THE INVENTION

With reference to Fig. 1, a typical page layout for the character-bearing, printable layer 10 of a display page contains a graphics portion 12, a series of membrane switches 14, and text 16. Although the graphics, membrane switch, and text portions of the page are shown in separate regions for ease of illustration, they may be interspersed, e.g. with the text containing instructions to depress the membrane switch at the end of the line of text, or a membrane switch incorporated into the illustrated scene. Additionally, text may be illuminated according to the present invention.

Printable layer 10 contains some translucent regions and a layer of EL lamps underlies printable layer 10 with the individual lamps positioned in a pattern corresponding to those portions of the graphics which are to be illuminated. For example, one EL lamp may be positioned under sun 32. Another lamp may be positioned to illuminate two closely-spaced parts of the illustration, such as clouds 34a-b. The characters may be the result of printing a positive silhouette, such as sun 32, on the outer face of printable layer 10 and a negative silhouette with dark ink directly underneath the positive silhouette. This refinement confines the illumination of the EL lamp below a character to that selected character. The EL lamps and printing can be combined to achieve a variety of effects. For example, a character may be printed on a translucent portion of a material of a single color and then change color when illuminated by an EL lamp of a different color. The characters themselves may be illuminated,

such as sun 32, or may be printed in dark ink and be backlighted when an EL lamp illuminates the background as is the case for the dark airplane in front of cloud 39. Characters may also be printed on the inner face only of printable layer 10, such as butterfly 42, so that illumination via EL lamp makes the character "appear" on the outer surface of printable layer 10. The graphics portion 12 may also contain non-activatable portions, such as at 38, which simply complete the illustrated scene.

A unique feature of the present invention is the sequencing of EL lamps to cause motion effects, such as animation. Individual EL lamps may be positioned beneath individual characters, e.g. the dolphin at each of positions 40a-d. When the appropriate switch is activated, the EL lamps luminance in a specified order, e.g. first the lamp at position 40a, then 40b, 40c, and finally 40d, giving the appearance of a jumping dolphin. When the sequencing circuitry is properly timed and ordered with the coordinating characters, animation effects may be achieved. In another instance, the characters may be printed on the inner surface of printable layer 10 in overlapping form and the EL lamps may be set at a rate designed to provide a smoother appearance of motion.

Activation of the EL lamps is caused by the membrane switches 14. A membrane switch may cause activation of one EL lamp and illumination of one character, as in sun 32 or butterfly 42, or activation of a series of EL lamps and a motion sequence within the graphics, as in the jumping dolphins at 40a-d.

The above-described printable layer 10 is presented as a single example of the top layer of a display page according to the present invention. Another display page having unique graphics, text, and EL lamp patterns may be affixed to the back of the first display page with the EL lamps facing inwardly and the character-bearing layers facing outwardly. The two together form a two-sided interactive EL display panel that serves as a sheet of a book. A plurality of display pages may be bound together in a book format, as with stitching at 28 and a fold line at 36 of Fig. 1.

The EL lamps of the assembled book preferably receive energy for luminescence from an internally housed source. Therefore, the assembled book preferably houses a power supply and circuitry common to the EL lamp patterns of each display page in a central area such as the spine 18 of the book, as illustrated in Fig. 1. The power to run the EL lamps may be supplied, e.g., by batteries 20 housed in a hollow tube 22 of spine 18 in conjunction with an inverter 26, also located within spine 18. Inverter 26 converts the DC voltage of the batteries into the AC voltage required to activate the EL lamps. Tube 22 is shown with a removable cap 21 at one end for replacement of the batteries 20. A battery input voltage in the range of 1-1/2 V to 12 V may be used, with 6 V preferred. Typically, the inverter output is at a voltage in the range of 80 to 160 V and a frequency in the range of 400 to 2000 Hz, with 100 V and 1200 Hz preferred. Sequencing circuit 24 is also shown located in spine 18 of Fig. 1 because in the illustrated example, a single sequencing circuit having a set pattern is used for the motion-sequenced graphics of each display page. Alternatively, different timing and ordering patterns may be used for each display page.

Fig. 1 also shows electrical leads 30 and wiring 44 connecting to the circuitry for the EL lamp patterns of each display page. The sheets of the book are aligned and preferably conductive epoxy, not shown, is then used to interconnect the circuitry of the display pages, the power supply, and the sequencing circuit. Alternatively, metal eyelet-type rivets may be used to interconnect the circuitry.

Referring to Fig. 2, character-bearing, printable layer 10 is shown with a printed positive silhouette 102 on its outer surface. A negative silhouette of the same character is printed on the backside, or inner surface, of printable layer 10, as indicated by 104. The characters may be printed with ink on the outer surface, inner surface, or both depending on the desired effect, as discussed above.

Below the printable layer 10 lies the EL lamp layer. The EL lamps of the present invention are preferably discrete cells which are situated close to printable layer 10 for maximum brightness of the overlying characters. For ease of illustration, the EL lamp layer has been separated into its components, but the connecting circuitry is not shown. The EL lamp layer shown is a typical EL polymer thick film with a top electrically conductive and light-transmissive ink pattern 86 serving as a top electrode and a bottom electrically conductive ink pattern 90 serving as a bottom electrode. Top electrode 86 is preferably disposed on the underside, or inner surface, of layer 100. Bottom electrode 90 is preferably disposed on the top, or outer surface, of layer 106. "Inner" and "outer" surfaces, as used here, refer to positions relative to a core or base, such as base substrate 98, of a typical display page or display sheet. Between the two electrodes lies the EL phosphor 88, which may also be in the form of an ink, and a dielectric 92. The electrodes 86 and 90 are aligned with the EL phosphor 88 and dielectric material 92 to form the EL lamp. Top electrode 86 is made light-transmissive to emit the luminescence of EL phosphor 88. A pattern of EL lamps is shown in Fig. 2 corresponding to selected characters of printable layer 10.

Although the various components of the EL lamps are shown as being incorporated in different segments of film, such as 100, 92 and 106, the present invention may be manufactured with the EL lamps being "printed" directly on the inner surface of printable layer 10. The components are thus laid down as successive coatings of first conductive ink, phosphor, dielectric matrix material, and second conductive ink. A combination of the coating and separate layer methods may be used to effectively combine layers 10 and 100 or 106 and 98, so that the conductive ink patterns are printed directly on layers 10 or 98 and only a separate dielectric and phosphor layer is between them. See Fig. 5. This combination of layers is also applicable to the conductive ink traces for the membrane switches, described below. Other types of EL lamps, such as those utilizing foil electrodes or phosphor-impregnated resins may also be used.

Also below printable layer 10 are the inner components of membrane switches 14. Figs. 2 and 3 illustrate the design of membrane switch 14, without connecting circuitry. The membrane switch includes a top pair of parallel spiral conductive ink traces 52 on a first surface, such as the underside of layer 100 or the inner surface of printable layer 10, and a bottom pair of parallel spiral conductive ink traces 54 on a second surface, such as the top surface of layer 106, as in Fig. 2, or base substrate 98, as in Fig. 3. The two sets of spirals are positioned to face each other, but are spaced apart with a spacer layer of predetermined thickness. The spacer layer contains apertures 50 which are aligned with the top and bottom sets of spirals 52 and 54, respectively. Printable layer 10 is printed with activation regions 46 of the membrane switches 14 indicating where the user should depress the switch. When the activation region 46 of a switch is depressed, top spiral set 52 comes into contact with bottom spiral set 54 through aperture 50, thus activating the switch and closing a circuit.

Although the spacer layer containing apertures 50 is shown in Fig. 2 as layer 92, i.e. the dielectric layer of the EL lamps, this is not a requirement. The spacer layer for membrane switches 14 may be completely separate from the EL lamp components and this is especially true if the EL lamps are formed as ink and resin

coatings on the inner surface of printable layer 10. The layers of membrane switches 14 which contain the top set of spirals 52 and the activation regions 46 are preferably made of flexible material such that depression of activation region 46 causes sufficient deflection of those layers to allow contact of the top and bottom sets of spirals 52 and 54. A material such as Mylar offering flexibility for light-pressure touch aetivation and durability for use in children's books is preferred.

The display pages of the present invention are preferably constructed using nonporous, flexible polymer substrate materials such as Mylar. Paper or fabric may also be used. It may be desirable to use core substrates and spacer layers that are semi-rigid, however, for durability. The printable layers are preferably 0.003 to 0.020" thick. The base substrate 98 of Fig. 2 is preferably 0.010 to 0.035" thick. Layers 100 and 106 of Fig. 2 are preferably 0.010 to 0.020" thick. The dielectric layer 92 varies depending on the voltage used, but a thickness of 0.010 to 0.030" is typical.

The printable layer 10 and underlying EL lamp and internal membrane switch layers 100, 92, and 106, are repeated in reverse form on the flip side of base or core substrate 98. Thus, Fig. 4 shows a cross-section of a complete double-sided, typical display sheet of the present invention. Layers 10, 100, 92, 106 and 98 are followed in order by a layer 106', similar to 106, a layer 92', similar to 92, a layer 100', similar to 100, and another character-bearing, printable layer 10', having a different scene in its graphics region and different text than printable layer 10. Preferably, the membrane switches on a first display page, or one side, shown e.g. as printable layer 10, of a double-sided display sheet, are not located directly opposite the membrane switches on the attached display page, or second side, shown e.g. as printable layer 10', of a double-sided display sheet. This placement avoids undesired activation which would waste battery power. Layers 92 and 92' are shown containing EL phosphors 88 and 88', respectively, and apertures 50 and 50', respectively. Conductive patterns and traces 86 and 52 are indicated on layer 100, as are 86' and 52' on 100'. Similarly, conductive patterns and traces 90 and 54 are indicated on layer 106, as are 90' and 54' on 106'. Membrane switch activation regions 46 and 46' are also shown on the printable layers. Fig. 4 shows positions A-D as possible locations for characters which are backlighted by the EL lamps. Additionally, the assembled double-sided display sheet may contain laminated coverings for durability.

One alternative structure, described above and illustrated in Fig. 5, has a portion, i.e. the light-transmissive top electrodes 86 and 86', of each pattern of EL lamps printed on the back of the printable layer 10 or 10', eliminating layers 100 and 100'. The EL phosphor material 88 or 88' may also be included in the portion of EL lamp that is printed on the inner faces of printable layers 10 and 10'. Fig. 5 also shows layers 106 and 106' removed, as compared with Fig. 4. The bottom electrodes 90 and 90' are printed, then, on either the inner faces of dielectric layers 92 and 92' or on the surfaces of base substrate 98.

A further alternative structure for the display sheet of the present invention has a single EL film layer forming a core that may be used to illuminate both display pages of a double-sided display sheet, as illustrated in Fig. 6. This requires the EL film layer to be light-transmissive in directions towards both display pages, however. Fig. 6 shows a single EL film layer, i.e., the EL phosphor dielectric material, and top and bottom electrodes, serving to illuminate characters on both of the printable layers 10 and 10'. One EL lamp causes illumination at position A on layer 10 because its light-transmissive portion, 86 and 88, is directed toward layer 10. The other EL lamp has its light-transmissive portion, 86' and 88', directed toward layer 10' and thus causes

illumination at position D. EL lamps that luminesce in both directions simultaneously may also be used. Note that in Fig. 6, the internal portions of the membrane switches are shown in adjacent positions of a single layer, but each has an activation region 46 or 46' in printable layer 10 or 10', as appropriate.

Fig. 7 contains an example of the electrical circuitry for a first page 60 and a succeeding page 62. Each page shown contains three simple EL lamps: 65, 67, and 69 on page 1 and 75, 77, and 79 on page n. The pages also each contain a sequenced series of EL lamps: 71a-f on page 1 and 81a-f on page n. All of the EL lamps are activatable by membrane switches whose activation regions are printed on the character-bearing printable layers overlying the lamps. For simplicity, the two pages contain identical EL lamp patterns. Different patterns may be used on the pages, however.

The membrane switches 14 of the present invention are preferably of a double pole design, meaning that two poles of the switch are closed simultaneously. Fig. 7 shows the two poles of a single membrane switch as 64a-b. Activation of the membrane switch operably connected to EL lamp 65 closes the circuit at poles 64a at 60 and 64b at 60' and allows the AC voltage provided by DC voltage 84 and inverter 26 to cause luminescence of EL lamp 65. Simple EL lamp page circuitry 72 similarly allows luminescence of lamps 67 upon activation of switch 66a-b and lamp 69 upon activation of switch 68a-b. In the same manner, simple circuitry 82 for page n allows luminescence of lamps 75, 77, and 79 upon activation of switches 74a-b, 76a-b, and 78a-b respectively, with poles located at 62 and 62'.

Double-pole membrane switches are also utilized for activation of the sequenced series of EL lamps. Page 1 shows EL lamps series 71a-f activated by switch 70a-b. When the circuit is closed, sequencing circuit 24 through circuitry 58 causes luminescence of EL lamps 71a-f according to a set timing and ordering pattern. The sequencing circuit 24 is also operably connected to page n via sequencing circuitry 58. Thus, activation of switch 80a-b causes sequenced luminescence of EL lamp series 81a-f.

Each display page of the present invention is similarly connected to preferably both the sequencing circuitry 58 and the circuitry for simple luminescence, depending on the illumination requirements of the page. The placement and number of EL lamps for the EL lamp pattern of each page may vary. Additional electrical sequencing patterns may be set in the sequencing circuit, so that the timing and order of illumination on the various pages having sequenced lamp series need not be identical. Also, more than one sequenced lamp series may be present on a single page. The multiple sequenced lamp series on a page may contain different electrical sequencing patterns.

The double-pole membrane switch design allows the single electronic sequencing circuit 24 shown in Fig. 7 to control the sequenced series of EL lamps on all pages of the book individually. The first pole 70a, e.g., controls the sequencing circuit 24 and the second pole 70b connects the specific page, here 60', to the return side of the inverter 26.

The present invention provides a unique usage for EL lamps and membrane switches that will easily find application for educational and entertainment purposes.

With reference to Figs. 8 and 9, a second embodiment of the present invention is shown including a typical page layout for an icon bearing, printable layer 110 of a substrate that contains a graphics portion 112 and a text portion 114. The substrate may be a greeting card, a page of a book, a panel or other sheet material. For

purposes of description, the substrate will be an interactive board game. Graphics portion 112 and text portion 114 are shown in separate regions for ease of illustration and may be interspersed, e.g., with the text positioned proximate to a particular graphic providing detailed information about the same. Additionally, text may be illuminated according to the present invention.

Layer 110 typically includes two sets of icons. A first set of icons 116, shown with solid lines, are formed to be viewable with the unaided eye on an essentially continuous basis. In this manner, icons 116 reflect light which is incident thereon. A second set of icons 118, shown in dashed lines, are formed to be selectively viewable with the unaided eye. Typically, icons 118 are translucent regions, which are printed on the inner face only of layer 110. A layer of EL material 120 underlies layer 110 and is formed to luminesce in areas adjacent to the translucent regions, which correspond to icons 118. For example, an EL area may be positioned under sun 122, as well as areas 122a-c. Another EL area may be positioned to illuminate two closely-spaced parts of the illustration, such as clouds 124a-b. The icons may be the result of printing a positive silhouette, such as sun 122, on the outer face of printable layer 110 and a negative silhouette with dark ink directly underneath layer 110 adjacent to the positive silhouette and proximate to the areas 122a-c. This refinement confines the illumination of the EL material to a region of layer 110 associated with icons of either the first 116 or second 118 set. In this manner, illumination of icons 118 via EL material allows icons to seem as though they "appear out-of nowhere" on the outer surface of printable layer 110. EL material 120 and printing can be combined to achieve a variety of effects. For example, a graphic may be printed on a translucent portion of a material of a single color and then change color when illuminated by an EL device of a different color. The icons themselves of the first set 116 may be illuminated, such as sun 122, or may be printed in dark ink and be backlighted when an EL device illuminates the background as is the case for the dark airplane in front of cloud 126. The graphics portion 112 may also contain non-activatable portions which simply complete the illustrated scene.

The shapes of the translucent regions are logically associated with one or more of the icons of the first set 116. For example, water 130 may be one of the icons of first set 116 and may have, associated therewith, dolphins 130a-d, which may be four of the icons of the second set 118. Dolphins 130a-d would not be viewable until EL material 120 is activated. To activate EL material 120, a plurality of switches/buttons 132 may be employed, or a microphone may be connected to allow voice activation of the EL material. Although switches are shown positioned in a region separate from graphics portion 112, it is preferred that switches 132 be positioned so as to lie underneath dolphins 130a-d. With this design, it is necessary to use flexible membrane switches, which are well known in the art. To operate the switches 132, it is understood that both EL material 120 and layer 110 must also be formed from a flexible material.

By properly sequencing the illumination of EL material 120, an illusion of motion may be achieved with respect to icons 118. In another instance, the icons may be printed on the inner surface of layer 110 in overlapping form, and the EL material may be set at a rate designed to provide a smoother appearance of motion. Overlapping EL areas could include sun 122b and cloud 117. Sun 122b and cloud 117 may be disposed so that they are not viewable until the EL area positioned underneath the same illuminates, as discussed above with respect to icons 118. In this fashion, at the initiation of the illumination sequence of 122c, 122b and sun 122a, the EL material associated with cloud 117 would be illuminated. Upon illumination of cloud 122b, EL material

corresponding to letter 149 extinguishes, momentarily leaving only cloud 122b illuminated. By carefully overlapping a succession of similar images in this manner, a relatively smooth appearance of motion may be achieved.

A sound generator, shown more clearly in Fig. 4, is coupled to a speaker 134 to produce an audible response which may be associated with icons of the first 116 second 118 sets. When the sequencing circuitry is properly timed and ordered with the icons and audible responses, visual animation may be achieved with corresponding audio accompaniment. For example, upon illumination of dolphin 130a. sound generator may produce the sound of breaking water to imitate the sound of a dolphin emerging from water 130. During the illumination of dolphins 130b-c. sound generator may produce the sounds of the dolphin clatter, or speech. In this fashion, the sound generator may produce a sequence of audible responses associated with the sequence of illumination of icons of the first 116 and second 118 sets. Further, each audible response in a sequence may be uniquely associated with the illumination of a particular icon of either the first 116 or second 118 sets.

If an amusing scenario is to be produced, the sound generator may imitate the sound of a jet airliner, missile or Apollo-NASA Communications sequence during the illumination of dolphins 130b-c, exaggerating the flight of the same across water 130. Finally, upon illumination of dolphin 130d, sound generator may produce the sound of a large splash, emphasizing the return of the dolphin to water 130. The combined audio visual stimuli provides the full effects of a motion picture.

Layer 110 is shown with a printed positive silhouette 122 on its outer surface. A negative silhouette 122 of the same icon is printed on the backside, or inner surface, of layer 110, as also indicated by 122a-c. The icons may be printed with ink on the outer surface, inner surface, or both depending on the desired effect, as discussed above. Below layer 110 lies the EL material 120. EL material 120 of the present invention includes a plurality of electroluminescent regions each of which comprises of EL phosphor 138 disposed between a top conductor 140 and a bottom conductor 142. Preferably, each electroluminescent region is situated proximate to layer 110 for maximum brightness of the overlying icons of second set 118. For ease of illustration, EL material 120 has been separated into its components, but the connecting circuitry is not shown. Top conductor 140 is typically formed on EL polymer thick-film as an electrically conductive ink. Preferably, top conductor 140 is disposed on the underside, or inner surface, of layer 144 proximate to graphics of first set 118 and is light-transmissive to allow light from EL phosphor 138 to pass therethrough. Bottom electrode 142 is preferably disposed on the top, or outer surface, of layer 146. "Inner" and "outer" surfaces, as used here, refer to positions relative to a core or base, such as base substrate 148, of a typical display page or display sheet. EL phosphor 138 is typically in the form of a conductive ink disposed on a dielectric 150. Electroluminescent regions, shown in Fig. 9, correspond to selected icons of layer 110.

Although the various components of EL material 120 are shown as being incorporated in different segments of film, such as 144, 146 and 150, the present invention may be manufactured with all components of EL material 120 being "printed" directly on the inner surface of layer 110. The components are thus laid down as successive coatings of first conductive ink, phosphor, dielectric matrix material, and second conductive ink. A combination of the coating and separate layer methods may be used to effectively combine layers 110 and 144 or 146 and 148, so that the conductive ink patterns are printed directly on layers 110 or 148 and

only a separate dielectric and phosphor layer is between them. This combination of layers is also applicable to the conductive ink traces for the membrane switches, described below. Other types of EL material, such as those utilizing foil electrodes or phosphor-impregnated resins may also be used.

Referring also to Fig. 10, below selected icons are the inner components of flexible membrane switches 132. Switches 132 are shown without connecting circuitry for ease of discussion. Each membrane switch 132 includes a top pair of parallel spiral conductive ink traces 152 on a first surface, such as the underside of layer 154 and a bottom pair of parallel spiral conductive ink traces 156 on a second surface, such as the top surface of layer 158. The two sets of spirals are positioned to face each other, but are spaced apart with a spacer layer 160 of predetermined thickness. Spacer layer 160 contains apertures 162 which are aligned with the top and bottom sets of spirals 152 and 156, respectively. As discussed above, in the preferred embodiment, membrane switches 132 may be disposed underneath one of the electroluminescent regions of EL layer 120 which switch 132 will cause to illuminate. Upon depressing the selected icon on layer 110, the top spiral set 152 comes into contact with bottom spiral set 154 through aperture 150, thus activating switch 132, closing a circuit and illuminating electroluminescent regions of EL layer 120. To this end, switch 132 is typically positioned proximate to layer 148, with layer 110 and all of the intervening layers between switch 132 and layer 110 being flexible. Upon depressing the appropriate switch 132, an icon of the first set 116 may be provided motion by icons of the second set 118. For example, the sound generator may prompt a user with an audible response as follows: "Watch the sun rise". After hearing the aforementioned audible response, a user would press on icon 122. This would cause switch 132, shown on layer 148, to cause phosphor A to irradiate light. Timing circuitry, discussed later with respect to Fig 11, would sequentially illuminate and unilluminate phosphor B, C, and D. This in turn would cause icons 122c, 122b and 122a to appear and disappear, leaving only icon 122 illuminated. After the illumination sequence of 122c, 122b and 122a has ended, an appropriate audible response could be generated.

In addition, some or all of switches 132 may not be disposed underneath EL material 120. Rather, some flexible membrane switches 164 may be formed in the same layers as EL material 120. In this manner, switch 164 may be disposed in the graphic portion 112 underneath a graphic associated with the first set 116, to indicate where a user can locate switch 164. Switch 164 includes a top pair of parallel spiral conductive ink traces 166 which may be disposed on surface 144, as well as a bottom pair of parallel spiral conductive ink traces 168, which may be on the top surface of layer 146, or base substrate 148. An aperture 170 may be positioned between top 166 and bottom 168 traces to perform the same functions as aperture 158, discussed above. Switches not included in the graphic portion 112 typically have, associated therewith, an activation region 172 to indicate where the user should depress switch 164 to activate EL material 120. When the activation region 172 of a switch is depressed, top spiral set comes into contact with bottom spiral set, as discussed above.

Referring also to Fig. 11, an advantage with having the EL material 120 and layer 110 disposed above switch 130 is to make the present invention easily adaptable to existing board games that provide audio stimuli. Such games typically employ sound cards activated by flexible membrane switches. By layering both the EL material 120 and layer 110 over the existing flexible membrane switches, an existing audio board game may be easily upgraded to provide visual stimuli. The existing flexible membrane switches are coupled to both the EL material 120 and the sound generator to simultaneously activate both audio and visual stimuli. The visual stimuli

provided may be designed to enhance the existing audio programming of the board game. Alternatively, many of the preexisting board games may be easily reprogrammed to change the sounds generated to enhance the visual stimuli. In this manner, existing board games may be easily and incxpensively altered to keep apace with the rapidly changing trends of children's entertainment.

An additional benefit with the layered design concerns the efficient use of substrate on which the switches and EL material are disposed. Specifically, with the layered design, more switches per unit area may be disposed in the board game, providing more interactive devices for a user. For example, an array or matrix of switches may be included. Top conductive traces 165 may be disposed spacecd apart from bottom conductive ink traces 167, with a plurality of corrcsponding apertures 169 disposed in an insulative layer therebetween, with corresponding eleetroluminescent regions being present. The advantage of having more interactive devices is that the game becomes more suitable for children of younger years. By placing the switch 130 underneath the icon which is the subject of attention, a one-to-one correspondence is facilitated between the icon and the visual response expected. This conecpt is easily demonstrated by considering the sound generator produeing the aforemcntioned audible rcsponse of "Watch the sun rise". Upon hearing this prompt, a user would merely press on icon 122 to elicit the visual response discussed above, thereby providing a one-to-one correspondence between icon 122 and the visual response expeeted. If the sound generator prompted the user to "see the dolphins jump", the aforemcntioned correspondence is not present. The dolphins may not be seen, preeluding the user from knowing where a switch is positioned to elicit the usual stimuli expected, i.e., the sequential illumination of dolphins 130a-d. Rather, a user would have to embark on an abstract association of water 130 with dolphins 130a-d. After making the aforementioned association, a user would understand the need to press on icon 130 to activate icons 130a-d. Many users of the present invention would not have developed the cognitive ability to make abstract associations. By placing switch 130 underneath an icon which is the subject of attention, less abstract thought proeesses need be utilized for a user to enjoy the interactive device. Simply put, the device becomes more suitable for users who have not developed the cognitive abilities necessary to successfully comprehend abstract associations.

The substrate of the present invention is preferably constructed using nonporous, flexible polymer substrate materials such as Mylar. Paper or fabric may also be used. It may be desirable to use core substrates and spacer layers that are semi-rigid, however, for durability. The printable layers are preferably 0.003 to 0.020" thick. The base substrate 148 is preferably 0.010 to 0.035" thick. Layers 144 and 146 are preferably 0.010 to 0.020" thick. The dielectric layer 150 varies depending on the voltage used, but a thickness of 0.010 to 0.030" is typical. Comparable dimension may be employed for flexible membrane switch layers 154, 158 and 160.

Each of the flexible membrane switches 132 is coupled to a printed circuit board (PCB) 174 via traces 176. A combination sound generator and sequencing circuit is disposed on the PCB 174 and may take the form of an integrated circuit coupled to speaker 134. A suitable power source, such as batteries 180, are provided to power the device. A power button 182 is coupled to the power source to selectively actuate the interactive device. A housing is provided which includes upper 184 and lower 186 casings. Upper casing 184 includes a window 188. Additional openings are provided to mount button 182 and speaker 134 so that they may be operationally coupled to upper casing 184. Layer 110 is mounted to be adjacent to window 188, with EL material 120 disposed adjacent thereto. Spaced apart from the EL material 120 is an array of flexible membranc switches.

Disposed between the EL material 120 and the switch array are traces 176, with lower casing 186 fastening to upper casing 184 via screws or the like.

Referring to both Figs. 12A and 12B, a roll-up display panel 210 is shown as having a flexible web 212, one end 214 of which is mounted to an elongated member 216. End 218 of flexible web 212, opposite to end 214, includes a handle 220 affixed to a rigid body 222. Flexible web 212 includes a light emitting pattern 224 which comprises of a tier 226 of electroluminescent (EL) material. A top layer 228 is disposed so as to cover tier 226 and may include one or more sets of icons which are associated with pattern 224. For example, a first set of icons 230, shown with solid lines, are formed to be viewable with the unaided eye on an essentially continuous basis. In this manner, icons 230 may reflect light which is incident thereon. A second set of icons 232, shown in dashed lines, are formed to be selectively viewable with the unaided eye. Circuitry 234 is disposed on a printed circuit board, which is attached to elongated member 216, and is electronically coupled to activate the EL material 226 to produce light. Circuitry 234 includes a sound generator 236 having a speaker, to produce predetermined audible signals. A sensor 238 is coupled to circuitry 234, causing it to activate the EL material 226, and/or sound generator 236 in response to sensor 238 detecting one or more stimuli, e.g., light, motion, heat or sound. To that end, circuitry 234 may include a microprocessor 240 and associated memory 242 containing preprogrammed sounds and illumination sequences, discussed more fully below. Display panel 210 may be powered by any suitable power source, e.g., a battery or by coupling to AC power via a plug 244 and appropriate rectification and voltage reduction.

Flexible web 212 is adapted to move between an extended position, shown in Fig. 12A, and a closed position, shown in Fig. 14. In this fashion, display panel 210 is considered extendable and retractable. Referring also to Fig. 12A, in the open position, flexible web 212 is extended so that end 218 is positioned distally from both elongated member 216 and end 214. Typically, elongated member 216 is weighted to sufficiently straighten flexible web 212 so as to provide a substantially flat surface. To this end, in operation, handle 220 is typically placed upon a protrusion extending from a vertical surface, with the elongated member 216 pulling flexible web 212 taut, under force of gravity. To place flexible web 212 in the closed position, elongated member 216 is moved, typically by hand, to rotate about its longitudinal axis 246 until flexible web 212 is completely coiled about axis 246. This places end 218 proximate to elongated member 216.

Referring also to Fig. 15, an alternate embodiment of the display panel 210, a hollow body 290 is provided, with the elongated member 216 rotatably disposed therein. A slot 292 extends parallel to axis 246 with flexible web 212, extending therethrough. As with the embodiment discussed above with respect to Figs. 12a-214, flexible web 212 is adapted to extend between the extended and closed positions. However, in the embodiment shown in Fig. 15, body 290 encases flexible web 212 when placed in the second position. Upon reaching the second position, handle 220 and rigid body 222 are disposed in abutting relation with slot 202. Hollow body 290 is typically watertight. A flexible membrane, such as rubber, is disposed about the periphery 294 of slot 292 so that a watertight seal is formed upon flexible web 212 reaching the closed position. Various means may be employed to facilitate movement between the open and closed positions. For example, a reversible motor may be connected to elongated member 216 to move the same, as disclosed in U.S. Pat. No. 5,296,964 which is incorporated by reference herein. An advantage with providing a reversible motor is that the motor may be connected to operate in

response to sensor 238 detecting the appropriate stimuli, as discussed above. This would allow panel 210 to extend automatically, allowing pattern 224 to be displayed and then retract, thereby providing flexible web 212 with greater protection from environmental conditions. Alternatively, flexible web 212 may be moved between, and positioned in, the open and closed positions by a torsional force supplied by a bearing bracket, as described in U.S. Pat. No. 4,169,658, which is incorporated by reference herein. Finally, a supporting structure, as disclosed in U.S. Pat. No. 4,110,003, which is incorporated by reference herein, may be employed.

Referring again to both Figs. 12A and 13, icons 232 of the second set are typically translucent regions printed upon the inner face of layer top layer 228. Tier 226, underlying top layer 228, is formed to luminesce in areas adjacent to the translucent regions, which correspond to icons 232. For example, an EL area may be positioned under each of letters 248, as well as the cup 250 and saucer 252, each of which are printed on top layer 228. Another EL area may be positioned to illuminate two closely-spaced parts of the illustration, such as steam vapors 254a-e. The icons may be the result of printing a positive silhouette, such as letters 248, on the outer face of top layer 228 and a negative silhouette with dark ink directly underneath top layer 228 adjacent to the positive silhouette and proximate to the areas 254a-e. This refinement confines the illumination of the EL material to a region of top layer 228 associated with icons of either the first 230 or second 232 set. In this manner, illumination of icons 232 via EL material allows these icons to seem as though they "appear out-of- nowhere" on the outer surface of top layer 228.

EL material 226 and printing can be combined to achieve a variety of effects. For example, a graphic may be printed on a translucent portion of a material of a single color and then change color when illuminated by an EL device of a different color. The icons themselves of the first set 230 may be illuminated, such as letters 248, cup 250 and saucer 252, or may be printed in dark ink and be backlighted when an EL device illuminates the background. The top layer 228 may also contain non- activatable portions which simply complete the illustrated scene.

Referring also to Fig. 16, the shapes of the translucent regions are logically associated with one or more of the icons of the first set 230. For example, coffee 256, disposed in cup 250, may be one of the icons of first set 230 and may have, associated therewith, steam vapors 254a-e, which may be four of the icons of the second set 232. Steam vapors 254a-e would not be viewable until the EL area positioned under the steam vapors 254a-e is activated. Each electroluminescent region of tier 226 comprises of EL phosphor 258 disposed between a top conductor 260 and a bottom conductor 262. Preferably, each electroluminescent region is situated proximate to the region of top layer 228 to be illuminated, for maximum brightness of the overlying icons of the first 216 second 218 sets. For ease of illustration, EL material 226 has been separated into its components, but the connecting circuitry is not shown. Top conductor 260 is typically formed on EL polymer thick-film as an electrically conductive ink. Preferably, top conductor 260 is disposed on the underside, or inner surface, of layer 261 proximate and is light-transmissive to allow light from EL phosphor 258 to pass therethrough. Bottom conductor 262 is preferably disposed on the top, or outer surface, of layer 263. "Inner" and "outer" surfaces, as used here, refer to positions relative to a core or base, such as base substrate 264, of a typical display page or display sheet. EL phosphor 258 is typically in the form of a conductive ink disposed on a dielectric 259.

Although the various components of EL material 226 are shown as being incorporated in different segments of film, such as 259, 261 and 263, the present invention may be manufactured with all components of EL material 226 being "printed" directly on the inner surface of top layer 228. The components are thus laid down as successive coatings of first conductive ink, phosphor, dielectric matrix material, and second conductive ink. A combination of the coating and separate layer methods may be used to effectively combine layers 259, 261 and 263, so that the conductive ink patterns are printed directly on layers 228 or 264 and only a separate dielectric and phosphor layer is between them. This combination of layers is also applicable to the conductive ink traces for the membrane switches, described below. Other types of EL material, such as those utilizing foil electrodes or phosphor-impregnated resins, may also be used.

By properly sequencing the illumination of the EL areas corresponding to steam vapors 254a-e, an illusion of motion may be achieved. Moreover, steam vapors 254a-e may be printed on the inner surface of top layer 228 in overlapping form, and the EL areas may be set at a rate designed to provide a smoother appearance of motion. Sound generator 236 produces audible signals associated with icons of the first 230 second 232 sets. When the sequencing circuitry is properly timed and ordered with the icons and audible signals, visual animation may be achieved with corresponding audio accompaniment. For example, upon illumination of vapor 254a, speaker 236 emits the sound of wind to produce the impression of a cloud moving through the sky. During the illumination of vapor 254a-e, sound generator 236 may produce the sounds of decreasing volume to provide the impression of the steam vapors 254a-e becoming more distant. In this fashion, sound generator 236 may produce a sequence of audible signals associated with the sequence of illumination of icons of the first 230 and second 232 sets. Further, each audible signal in a sequence may be uniquely associated with the illumination of a particular icon of either the first 230 or second 232 sets.

Referring also to Fig. 1B, a novel configuration of the EL material could include overlapping EL areas such as vapor 254f and letter 249. Both vapor 254f and letter 249 may be disposed so that they are not viewable until the EL area positioned underneath the same illuminates, as discussed above with respect to steam vapors 254a-e. In this fashion, vapors 254a-f may be illuminated sequentially, under control of microprocessor 240, to provide an illusion of movement of one vapor traveling from cup 250 toward letter 249. To complete the phrase "GRAB A CUP OF COFFEE", letter 249 remains lit during the sequential illumination of vapors 254a-e. Upon illumination of vapor 254f, EL material corresponding to letter 249 extinguishes, leaving only vapor 254f illuminated. By carefully overlapping a succession of similar images in this manner, a relatively smooth appearance of motion may be achieved.

In addition, pattern 224 may be illuminated to correspond to static images, i.e., images illuminated that do not provide the illusion of movement. For example, letters 248 may be illuminated in any manner desired to capture the attention of nearby individuals. In this manner, letters 248 may be illuminated simultaneously or each of letters may be illuminated individually in a random sequence. Sound generator 236 may provide an audible signal, as discussed above. For example, sound generator 236 may include a voice synthesizer that would emit an audible signal stating the phrase or slogan illuminated. In this case sound generator would sound "GRAB A CUP OF COFFEE".

The EL material of tier 226 may be activated by any suitable means known in the art. Preferably, tier 226 would be activated in response to stimuli detected by sensor 238. For example, sensor 238 may be adapted to detected infrared radiation and could cause circuitry 234 to activate tier 226 and sound generator 236 in response to detecting heat emitted from a human body. Alternatively, sensor 238 may include a microphone and filtering circuitry tuned to detect the common frequencies produced by a human voice. Finally, sensor 238 may be adapted to detect optical energy and thus activate tier 226 and sound generator 236 upon detecting certain wavelengths of light, or in the absence of the same. Moreover, tier 226 and sound generator 236 may be activated in response to signals produced by a clock 235, or timer, included in circuitry 234. This would enable the display panel 210 to illuminate and produce sounds periodically or during preset times during the day.

Display panel 210 may be activated in response to activating individual switches 266. Switches 266 may be disposed either in the elongated member 216, hollow body 200 and/or flexible web 212. Although any switch may be employed, it is preferred that switches 266 (Fig. 12A) are flexible membrane switches as shown in Fig. 10, which are lightweight and energy efficient.

Referring again to Figs. 13 and 15, each of the flexible membrane switches 266 is coupled to circuitry 234 via traces 280 that terminate in an edge connector 282 positioned proximate to end 14. The edge connector is inserted in an edge connector receptacle 284 that is incorporated within circuitry 234. With this design, the flexible web may be easily replaced without undue cost while maintaining the utility of circuitry 234, elongated member 216 and hollow body 290. The sounds generated in response to activation of the EL material 226 may be easily and inexpensively changed by simply replacing memory 242. This allows a portable inexpensive flexible display device that is easily changed to provide the advertising, or display message desired.

CLAIMS

1. A display comprising,

a layer bearing a first set of a plurality of icons,

a tier of electroluminescent material disposed adjacent to said layer forming a pattern corresponding to said first set of icons, said pattern disposed to show a series of illuminated images corresponding to said plurality of icons of said first set, with said plurality of icons and said pattern arranged to provide an illusion of movement of said first set of icons upon said pattern being illuminated in accord with a perdetermined sequence, and

means, electronically coupled to said electroluminescent material, for activating said first pattern in accord with said predetermined sequence, with each of said plurality of icons of said first set adapted to be selectively viewable with an unaided eye upon said activating means illuminating said pattern.

2. The display of claim 1 wherein said pattern includes a plurality of electroluminescent lamps, with the activating means having

a plurality of membrane switches disposed in the tier, each switch providing contact of two conductive traces upon depression of an activation region, the contact causing switching of electric circuitry associated with at least one of the lamps,

a power supply means for causing luminescence of each lamp operably connected to the contact within each switch.

3. The display of claim 2 wherein the layer includes a second set of a plurality of icons, with said second set adapted to be viewable with said unaided eye on a continuous basis, whereby said first set is arranged to provide an illusion of movement of one of said second set of icons upon said pattern being illuminated in accord with said predetermined sequence.

4. The display of claim 2 wherein at least a portion of the pattern of EL lamps is printed on a surface of the layer.

5. The display of claim 1 wherein the character-bearing layer, lamps, and membrane switch are flexible.

6. An interactive book comprising,

(A) a plurality of display sheets, each sheet comprising,

(1) two printable layers, each layer having an inner face and an outer face, the layers printed with characters,

(2) at least one film of electroluminescent lamps disposed between the two inner faces of the printable layers, each lamp positioned to underlie at least one of the characters and having associated electric circuitry,

(3) a series of flexible membrane switches disposed in each sheet, each membrane switch connected to the electrical circuitry of at least one of the lamps and having a top activation region disposed in the outer face of one of the printable layers, two sets of conductive traces printed on two facing membrane layers below the activation region, and a spacer layer defining a hole, the spacer layer disposed between the two membrane layers with the hole positioned between the traces and below the activation region so that depression of the activation region allows contact of the traces through the hole of the spacer layer, the contact causing luminescence of at least one of the lamps, and in turn causing illumination of at least one of the characters,

(B) a power supply associated with the film of lamps, and

(C) means for connecting the display sheets into a book format

7. The book of claim 6 further comprising a sequencing circuit associated with a series comprising at least two of the lamps causing variable timing and ordering of the luminescence of the series.

8. The book of claim 7 wherein the sequencing circuit causes timing and ordering of the series such that the characters overlying the series appear to be animated.

9. The book of claim 6 wherein the printable layers are made of a flexible material in the range of 0.003 to 0.020 inch in thickness.

10. The book of claim 6 further comprising lamination coverings for the printable layers.

11. A display sheet with motion effects comprising,

a film of electroluminescent lamps, the lamps spatially arranged in a display pattern,

a first printable layer having characters thereon disposed over some of the lamps, whereby the characters may be backlighted by the lamps,

a second printable layer having characters thereon disposed over some of the lamps with the characters facing away from the film of lamps on a side distal to the first printable layer,

an electrical sequencing circuit for applying energy to the lamps in a predetermined timed order, and

a power supply connected to the sequencing circuit whereby motion effects may be produced by activating the lamps with the sequencing circuit.

12. The display sheet of claim 11 wherein the film of lamps and the printable layers are nonporous, flexible polymers.

13. The display sheet of claim 11 wherein the printable layers are paper.

14. The display sheet of claim 11 further comprising a contact switch formed by electrically conductive traces disposed below the first printable layer, the switch interposed between the sequencing circuit and the power supply.

15. The display sheet of claim 14 wherein the contact switch comprises a set of spiral traces on opposite sides of a spacer layer, with an aperture in the spacer layer allowing contact by opposed traces.

16. The display sheet of claim 15 wherein each set of spiral traces is further defined by a parallel pair of spiral traces and a first pole associated with the sequencing circuit and a second pole associated with the power supply.

17. The display sheet of claim 11 wherein the power supply comprises a cylindrical battery and an elongated inverter package housed in a hollow tubular spine, the display sheet having an edge joined to the spine.

18. The display sheet of claim 17 wherein the battery supplies voltage in the range of 1-1/2 to 12 volts.

19. The display sheet of claim 17 wherein the inverter package has an output in the range of 80 to 160 volts and 400 to 2000 hertz.

20. An interactive display panel comprising:

a layer bearing a plurality of icons, each of said plurality of icons being associated with one of a first set and a second set of icons;

a tier of electroluminescent material forming a pattern corresponding to said second set of icons, said pattern disposed to show a series of images corresponding to said first set of icons, providing an illusion of movement of one of said first set of icons upon said second set of icons being illuminated in accord with a predetermined sequence;

a generator means for producing a predetermined audible response; and

means, electronically coupled to both said pattern of electroluminescent material and said generator, for simultaneously activating both said generator means and said pattern, with said generator means producing said predetermined audible response upon said second set of icons being illuminated in accord with said predetermined sequence.

21. The display panel of claim 20 wherein said first set of icons is adapted to be viewable with an unaided eye on a continuous basis, and said second set of icons is selectively viewable with said unaided eye, whereby said second set of icons is viewable upon said activating means illuminating said pattern.

22. The display panel of claim 20 wherein said first set of icons is adapted to reflect and absorb light impinging thereon, with said second set of icons adapted to be translucent.

23. The display panel of claim 20 wherein said second set of icons comprises of a plurality of electroluminescent regions and said activating means includes a sequencing circuit associated with said plurality of electroluminescent regions to selectively illuminate each of said plurality of regions in accord with said predetermined sequence.

24. The display panel of claim 20 wherein said generator means produces an audible response uniquely associated with one of said second set of icons.

25. The display panel of claim 20 wherein said generator means produces a succession of audible responses corresponding to said predetermined sequence.

26. The display panel of claim 20 wherein said generator means produces a succession of audible responses corresponding to said predetermined sequence, with each of said audible response of said succession being uniquely associated with one of said icons of said second set.

27. The display of claim 20 wherein said pattern is disposed between said layer and said activating means.

28. The display page of claim 20 wherein said activating means includes a flexible membrane having a first conductive element and a contact layer having a second conductive element, with said flexible membrane being spaced apart from said contact layer, placing said first and second conductive elements in opposing relation with an insulative layer disposed therebetween, said insulative layer having an aperture aligned with said first and second conductive elements.

29. The display page of claim 20 wherein said pattern comprises a plurality of electroluminescent regions disposed in said tier with each of said plurality of regions including a pair of spaced apart electrodes with electroluminescent phosphor disposed therebetween.

30. The display page of claim 20 wherein said pattern includes a plurality of electroluminescent regions and said activating means includes a sequencing circuit associated with said plurality of electroluminescent regions to selectively illuminate each of said plurality of regions in accord with said predetermined sequence

31. The display page of claim 20 wherein said icon bearing layer is disposed proximate to said tier.

32. The display page of claim 20 wherein said activating means includes a flexible membrane having a first conductive element and a contact layer having a second conductive element, with said flexible membrane being spaced apart from said contact layer, placing said first and second conductive elements in opposing relation with an insulative layer disposed therebetween, said insulative layer having an aperture aligned with said conductive first and second conductive elements.

33. An interactive display panel comprising:

a layer bearing a plurality of icons, each of said plurality of icons being associated with one of a first set and a second set of icons, with said first set being adapted to be viewable with an unaided eye on a continuous basis, and said second set is selectively viewable with said unaided eye;

a tier of electroluminescent material forming a pattern corresponding to said second set of icons, said pattern disposed to show a series of images corresponding to said first set of icons, providing an illusion of movement of said first set of icons upon said second set of icons being illuminated in accord with a predetermined sequence;

means, electronically coupled to said electroluminescent material, for selectively illuminating said second set of icons in accord with said predetermined sequence, whereby each icon of said second set of icons selectively becomes viewable with said unaided eye.

34. The display panel of claim 33 wherein said activating means includes a flexible membrane having a first conductive element and a contact layer having a second conductive element, with said flexible membrane being spaced apart from said contact layer, placing said first and second conductive elements in opposing relation with an insulative layer disposed therebetween, said insulative layer having an aperture aligned with said conductive first and second conductive elements and said pattern comprises a plurality of electroluminescent regions disposed in said tier with each of said plurality of regions including a pair of spaced apart electrodes with electroluminescent phosphor disposed therebetween.

35. The display panel of claim 34 further including a generator means for producing a predetermined audible response, wherein said activating means is electronically coupled to both said pattern of electroluminescent material and said generator, for simultaneously activating both said generator means and said pattern, with said generator means producing said predetermined audible response upon said second set of icons being illuminated in accord with said predetermined sequence.

36. The display panel of claim 35 wherein said activating means includes a sequencing circuit associated with said plurality of electroluminescent regions to selectively illuminate each of said plurality of regions in accord with said predetermined sequence, wherein said generator means produces a succession of audible responses corresponding to said predetermined sequence.

37. The display panel of claim 36 wherein each of said audible response of said succession are uniquely associated with one of said icons of said second set of icons.

38. An interactive display panel comprising:

a layer bearing a plurality of icons, each of said plurality of icons being associated with one of a first set and second set of icons;

a tier of electroluminescent material forming a pattern corresponding to said second set of icons, said pattern disposed to show a series of images corresponding to said first set of icons, providing an illusion of movement of said first set of icons upon said second set of icons being illuminated in accord with a predetermined

sequence, said pattern comprising of a plurality of electroluminescent regions disposed in said tier with each of said plurality of regions including a pair of spaced apart electrodes with electroluminescent phosphor disposed therebetween;

a generator means for producing a predetermined audible response; and

means, electronically coupled to both said pattern of electroluminescent material and said generator, for simultaneously activating both said generator means and said pattern, with said generator means producing said predetermined audible response upon said second set of icons being illuminated in accord with said predetermined sequence, said activating means including a flexible membrane having a first conductive element and a contact layer having a second conductive element, with said flexible membrane being spaced apart from said contact layer, placing said first and second conductive elements in opposing relation with an insulative layer disposed therebetween, said insulative layer having an aperture aligned with said conductive first and second conductive elements.

39. The display panel of claim 38 wherein said activating means includes a sequencing circuit associated with said plurality of electroluminescent regions to selectively illuminate each of said plurality of regions in accord with said predetermined sequence, wherein said generator means produces a succession of audible responses corresponding to said predetermined sequence, with each of said audible response of said succession are uniquely associated with one of said figures of said second set.

40. A roll-up display panel comprising:

a flexible web having first and second opposed ends, said web including a tier of electroluminescent material forming an electroluminescent arrangement and a translucent top layer positioned with respect to said tier to cover said electroluminescent arrangement;

an elongated member defining an axis, said first end of the flexible web attached to said elongated member, with said flexible web being adapted to roll between extended and closed positions, with said second end of the flexible web being distally positioned with respect to said first end in said extended position and said flexible web being coiled around said axis in said second position; and

means, electronically coupled to said electroluminescent arrangement, for energizing said electroluminescent material to produce light, thereby producing a viewable pattern on said flexible web.

41. The display panel of claim 40 wherein said energizing means is disposed within said elongated member.

42. The display panel of claim 40 wherein said top layer includes a plurality of icons, each of which is associated with one of a first set and a second set of icons, with said electroluminescent arrangement corresponding to said second set of icons, said first set of icons being adapted to be viewable with an unaided eye on a continuous basis, and said second set of icons being selectively viewable with said unaided eye, whereby said second set of icons is viewable upon said activating means illuminating said electroluminescent arrangement.

43. The display panel of claim 40 further including a hollow body with said elongated member disposed within said body to rotate about said axis, with said body adapted to encase said flexible web upon reaching said second position.

44. The display panel of claim 40 further including a sensor means for activating said energizing means in response to said sensor detecting a predetermined stimuli.

45. The display system of claim 40 further including a means, coupled to said energizing means, for generating a predetermined audible response upon said electroluminescent arrangement producing light.

46. The display system of claim 40 further including means, attached to said second end, for mounting said system to a vertical surface.

47. The display system of claim 40 further including means, electronically coupled to said activating means, for illuminating said second set of icons in accord with a predetermined sequence.

48. The display system of claim 40 wherein said electroluminescent arrangement is disposed to provide an illusion of movement associated with one of said first set of icons upon said second set of icons being illuminated in accord with a predetermined sequence.

49. The display system of claim 40 wherein said top layer has an inner face and an outer face and includes a plurality of icons which form said pattern, said tier including electroluminescent lamps disposed with each lamp positioned to underlie at least one of said plurality of icons and having associated electronic circuitry and a series of flexible membrane switches disposed therein, each membrane switch connected to said electrical circuitry of at least one of said lamps and having a top activation region disposed proximate one of said plurality of icons.

50. A roll-up display panel comprising:

a flexible web having first and second opposed ends, said web including a film of electroluminescent lamps spatially arranged in a pattern, a top layer having icons thereon disposed over some of said lamps, whereby said icons may be backlighted by said lamps;

an elongated member defining an axis, said first end attached to said elongated member, with said flexible web being adapted to roll between extended and closed positions, with said second end being distally positioned with respect to said first end in said extended position and said flexible web being coiled around said axis in said second position; and

means, disposed within said elongated member and electronically coupled to said electroluminescent lamps, for energizing said electroluminescent lamps to produce light, thereby forming a viewable illuminated pattern.

51. The display panel of claim 50 further including a sensor means for activating said energizing means in response to said sensor detecting a predetermined stimuli.

52. The display panel of claim 51 wherein said predetermined stimuli includes motion.

53. The display panel of claim 51 wherein said predetermined stimuli is sound.

54. The display panel of claim 51 wherein said sensor in an infra-red detector adapted to sense thermal energy and said predetermined stimuli is a change in thermal radiation.

55. The display panel of claim 50 wherein said sensor in an infra-red detector adapted to sense thermal energy and said predetermined stimuli is a change in thermal radiation.

56. The display panel of claim 50 further including a hollow body with said elongated member disposed within said body to rotate about said axis, with said body adapted to encase said flexible web upon reaching said second position.

57. The display panel of claim 56 further including a motor means, disposed within said body to move said flexible web between said extended and closed positions.

58. A roll-up display panel comprising:

a flexible web having first and second opposed ends, said web including a tier of electroluminescent material forming an electroluminescent arrangement and a top layer positioned with respect to said tier to cover said electroluminescent arrangement;

an elongated member defining an axis, said first end attached to said elongated member, with said flexible web being adapted to roll between extended and closed positions, with said second end being distally positioned with respect to said first end in said extended position and said flexible web being coiled around said axis in said second position;

means, electronically coupled to said tier, for energizing said electroluminescent arrangement to produce light;

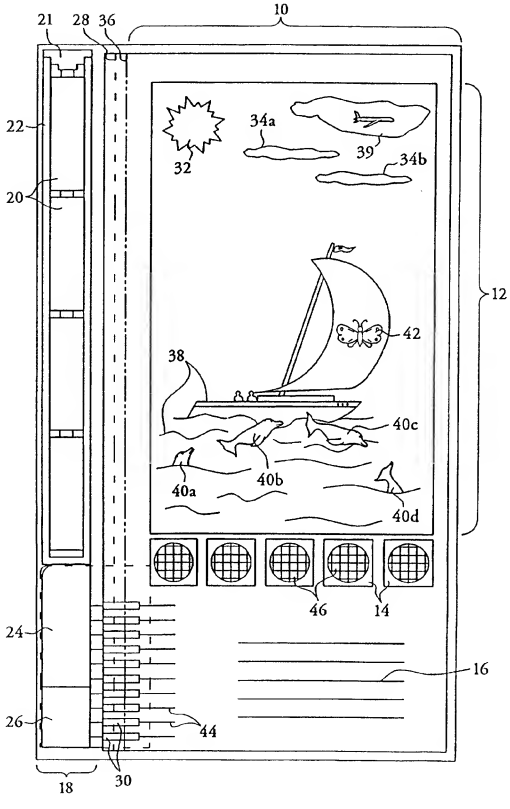
sensor means for activating said energizing means in response to said sensor detecting a predetermined stimuli; and

motor means, disposed within said body to move said flexible web between said extended and closed positions.

59. The display panel of claim 58 further including a timing means, electronically coupled to said energizing means, for periodically activating said energizing means, whereby said electroluminescent arrangement is illuminated periodically in accordance with said activating means.

60. The display panel of claim 59 wherein said motor means activates in response to said detector sensing said predetermined stimuli, whereby said display panel moves between said closed and extended position.

61. The display panel of claim 60 further including a hollow body with said elongated member disposed within said body to rotate about said axis, with said body adapted to encase said flexible web upon reaching said second position.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34a
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34b
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38
40c
40a
40b
40d
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14
24
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26
44
18
30

FIG. 1

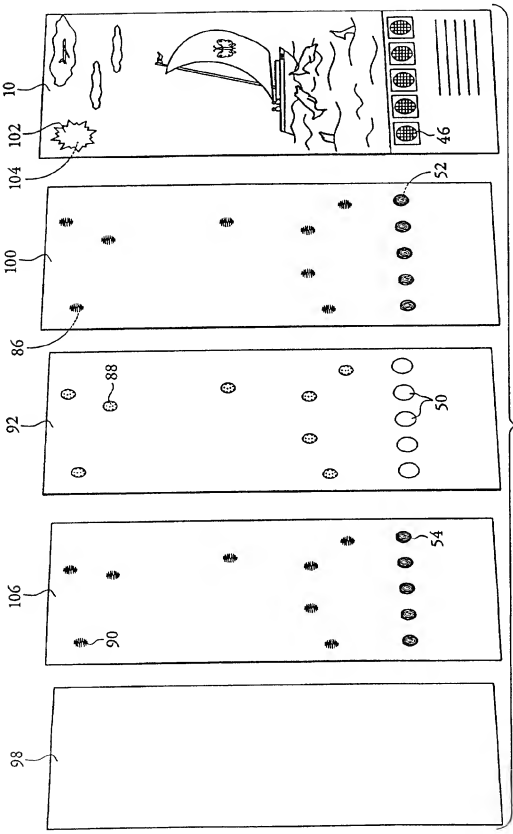
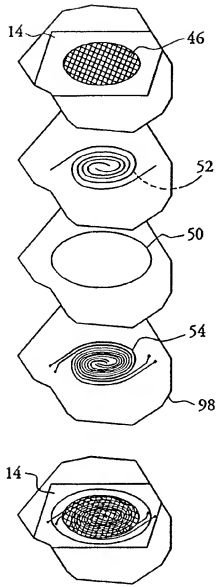


FIG. 2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54
98
14

FIG. 3

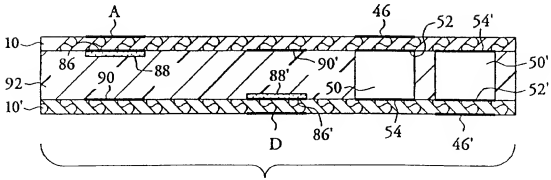
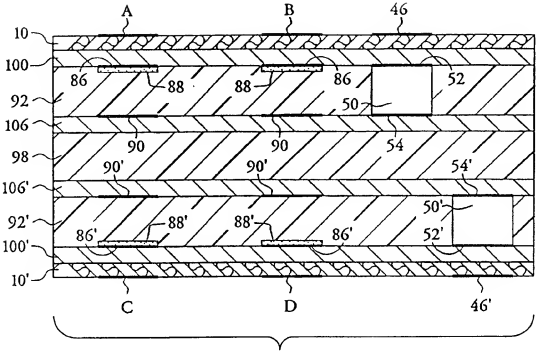

A
46
52
54'
10
86
90
88
90'
50'
92
88'
50
52'
10'
D
86'
54
46'

FIG. 6


A
B
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10
100
92
106
98
106'
92'
100'
10'
86
88
88
86
52
50
90
90
54
90'
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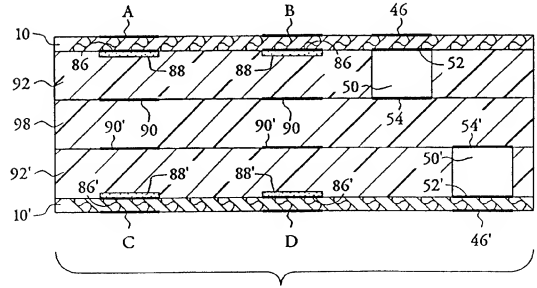
54'
50'
86'
88'
88'
86'
52'
C
D
46'

FIG. 4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B
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10
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98
92'
10'
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52
50
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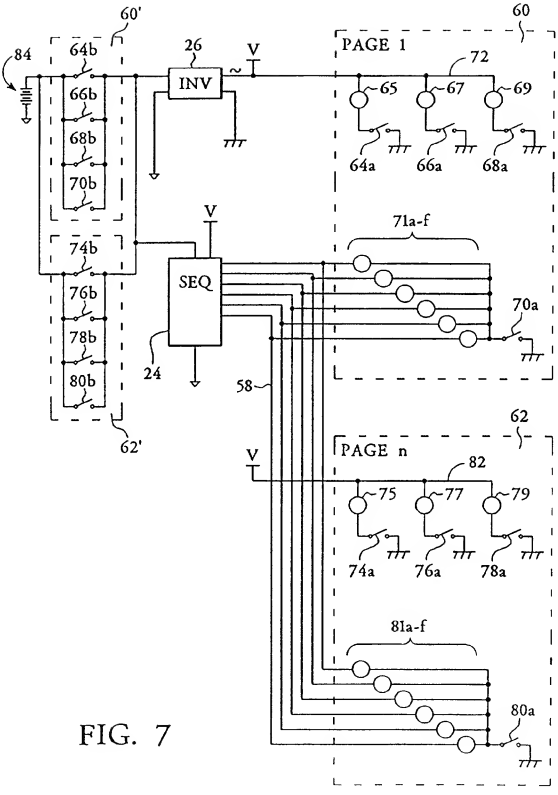
86'
52'
C
D
46'

FIG. 5


60'
60
84
64b
66b
68b
70b
74b
76b
78b
80b
62'
26
INV
V
SEQ
24
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PAGE 1
72
65
67
69
64a
66a
68a
71a-f
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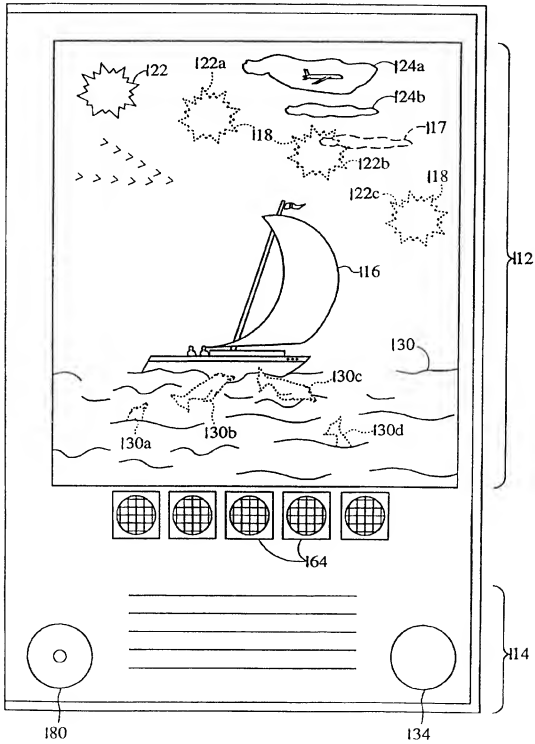
62
PAGE n
82
75
77
79
74a
76a
78a
81a-f
80a

FIG. 7


122
122a
124a
124b
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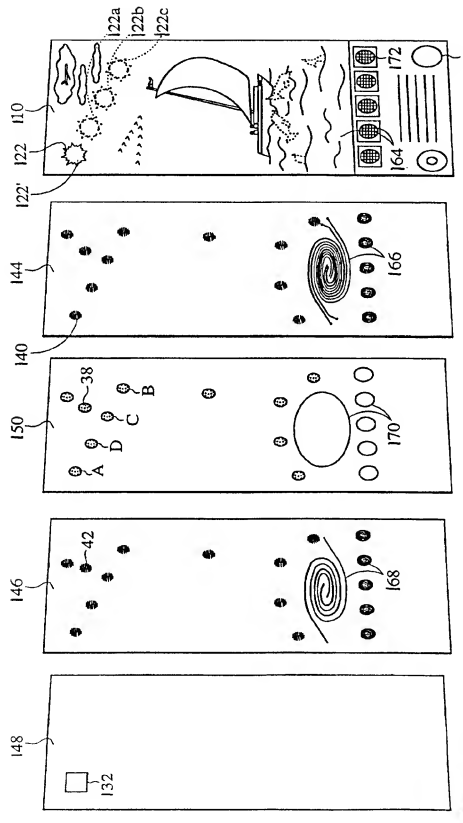
117
122b
118
122c
116
112
130
130c
130a
130b
130d
164
114
180
134

FIG. 8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122'
122a
122b
122c
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A
D
C
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120

FIG. 9

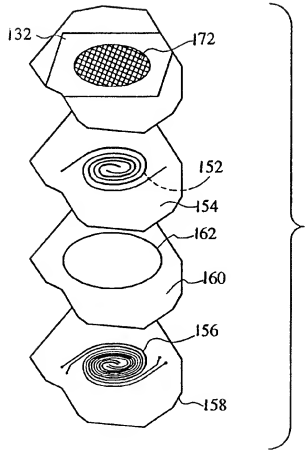

FIG. 10

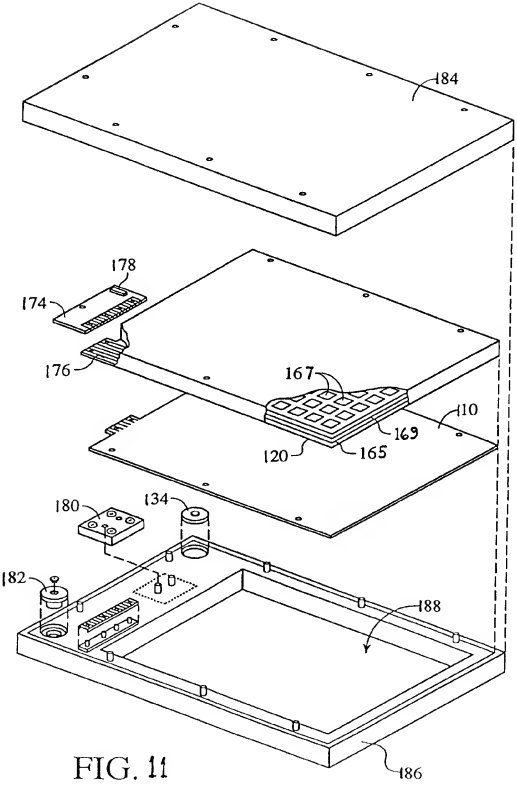

FIG. 11

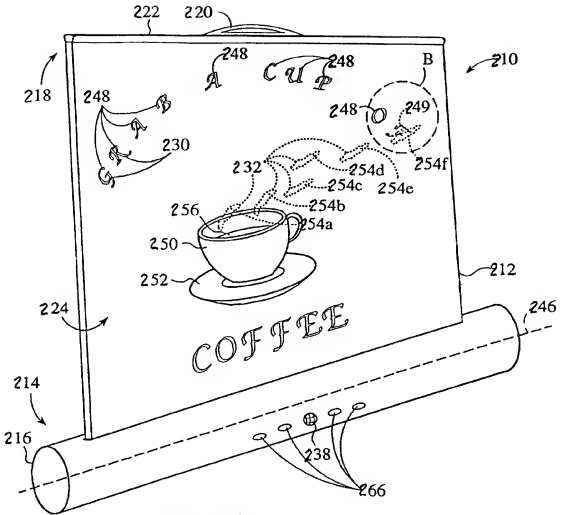

FIG. 12A

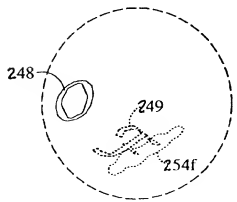

FIG. 12B

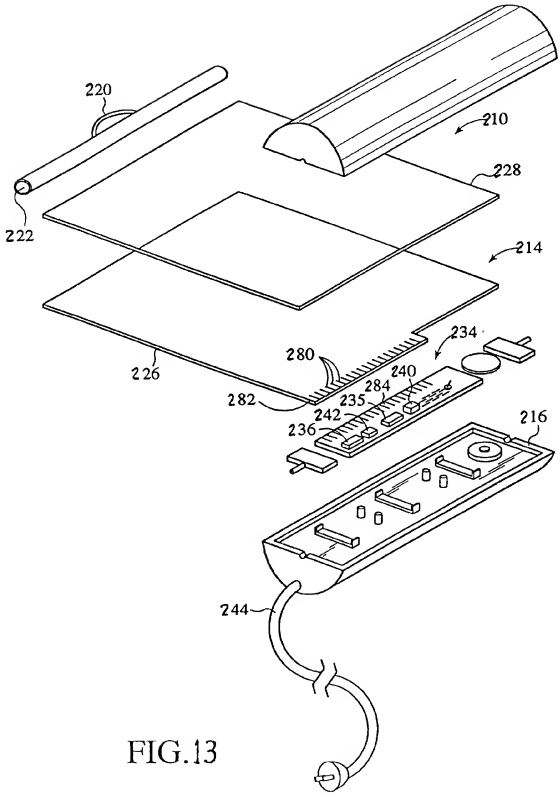

FIG.13

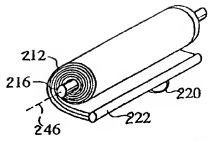
212
216
220
246
222

FIG.14

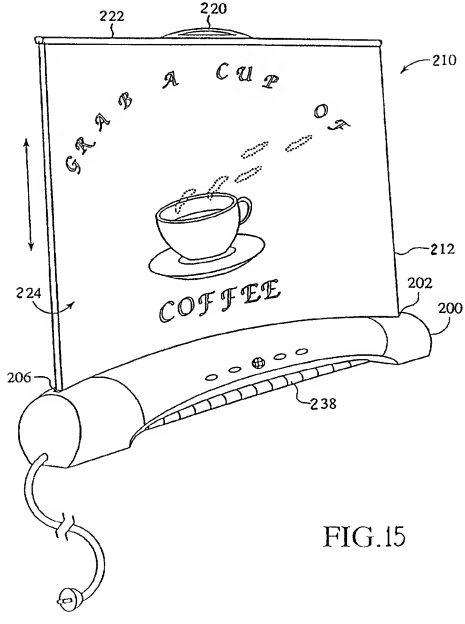
222
220
210
GRAB A CUP OF
COFFEE
212
224
202
200
206
238

FIG.15

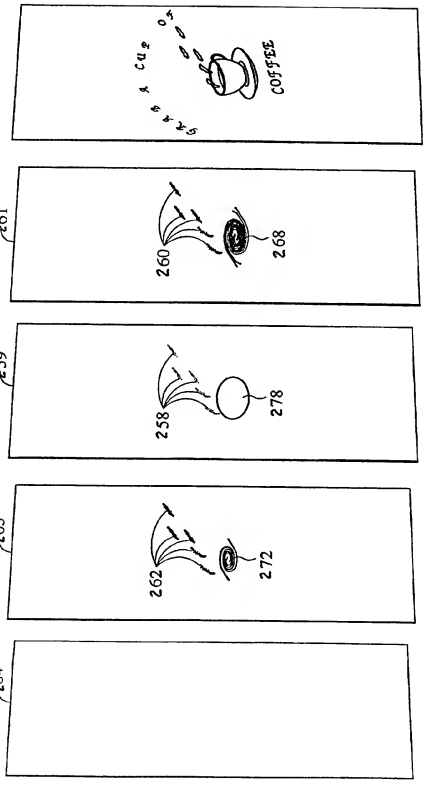

FIG.16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/12814

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G09G 3/12, 3/04, 3/34; A47F 11/06; G09F 13/00; G09B 5/00
US CL. :345/36, 43, 45, 108, 901; 40/427, 442; 434/308, 309, 317
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 345/36, 43, 45, 108, 901; 40/427, 442; 434/308, 309, 317

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, MAYA
SEARCH TERMS: ELECTROLUMINESCENT, EL, FLEXIBLE, ROLL UP, PAGE, BOOK

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A, E	US 5,652,930 A (TEREMY ET AL.) 29 July 1997, fig. 10 and 11, col. 3, lines 3-30, col. 7 lines 1-30.	40
A, P	US 5,597,183 A (JOHNSON) 28 January 1997, fig. 1-7, col. 1, lines 55-67, col. 2 lines 1-45.	1
Y	US 5,484,292 A (MCTAGGART) 16 January 1996, fig. 1-17, col. 2, lines 34-67, col. 3, lines 1-28.	1-39, 45-49, 52-54
Y	US 5,469,020 A (HERRICK) 21 November 1995, fig. 1-5, col. 6 lines 58-67, col. 7, lines 60-67.	40-57

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"B"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 12 NOVEMBER 1997	Date of mailing of the international search report 12 DEC 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer PAUL BELL Telephone No. (&03) 306-3019

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/12814

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,437,552 A (BAER ET AL.) 01 August 1995, fig. 1a, col. 1, lines 5-7, col. 2, lines 8-27, col 14, lines 46-55.	1
A	US 5,413,486 A (BURROWS ET AL.) 09 May 1995, fig. 2-6, col. 1, lines 51-68, col. 2, lines 1-30.	1
A	US 5,209,665 A (BILLINGS ET AL.) 11 May 1993, fig. 1a-f, col. 2, lines 29-68, col. 3, lines 1-52	1
A	US 5,087,043 A (BILLINGS ET AL.) 11 February 1992, fig. 1a and 2a, col. 1, lines 45-56.	1
Y	US 5,019,807 A (STAPLETON ET AL.) 28 May 1991, fig. 5, col. 1, lines 9-39.	40-61
A	US 4,730,146 A (MASER ET AL.) 08 March 1988, fig. 1, col. 1, lines 10-64, col. 6 , lines 28-68.	1
Y	US 4,703,573 A (MONTGOMERY ET AL.) 03 November 1987, fig. 1-3b, col. 1, lines 6-20, col. 4, lines 41-65, col. 7, lines 64-68.	1-5, 7-39
Y	US 4,683,360 A (MASER) 28 July 1987, fig. 1-5, col. 1, lines 5-10, col. 2 lines 41-53.	5-10, 28, 32
A	US 4,601,120 A (LEVIN) 22 July 1986, fig. 1 and 2, col. 1, lines 27-36, 45-48, col. 2, lines 1-10.	40
A	US 4,532,395 A (ZUKOWSKI) 30 July 1985, fig. 1, col. 1, lines 37-40.	1
A	US 4,299,041 A (WILSON) 10 November 1981, fig. 1, col. 1, lines 1-40, lines 30-45.	1
Y	US 3,037,137 A (MOTSON) 29 May 1962, fig. 1-6, col. 1, lines 39-48, 55-61, col 3. lines 43-75	40-57
Y	US 4,739,567 A (CARDIN) 26 April 1988, figure 1, column 1, lines 45-58, column 2, lines 15-68.	44, 51-56, 58-61
Y	US 4,110,003 A (ZINN) 29 August 1978, figure 1, column 1, lines 28-68.	43, 57, 61
Y	US 4,169,658 A (BROWN) 02 October 1979, figure 2, column 1, lines 24-55.	43, 57, 61